FARMERS' PARTICIPATION AND PERFORMANCE ANALYSIS OF GRAIN WAREHOUSE RECEIPT SYSTEM IN NAKURU DISTRICT, KENYA

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A Thesis Submitted to the Graduate School in Partial Fulfillment for the Requirement of the Master of Science Degree in Agricultural and Applied Economics of Egerton University

EGERTON UNIVERSITY

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Kimugi

DECLARATION AND APPROVAL

DECLARATION

I declare that this thesis is my original work and to the best of my knowledge has not been presented for any degree at any other university.

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APPROVAL

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DEDICATION

I dedicate this work to my wife Mrs Joyce Mutai, my children Lennox Tristan and Heidi, My mother Mrs Nelly Talam and my brothers and sisters for their extra ordinary support during the course of my study.

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ABSTRACT

Although maize performs well compared with other grains and legumes in Eastern and Southern Africa, there are challenges in production, post harvest handling and marketing of the maize produce. Majority of farmers sell the maize produce soon after harvest realizing low prices. As an effort to mitigate the challenge, the Government together with other development partners introduced Grain Warehouse Receipt System (GWRS) under Kenya maize development programme (KMDP). However, the success of the system is yet to be achieved hence the need to be re-examined. This study therefore analyzed level of awareness and factors that influence farmers' participation in Grain Warehouse Receipt System (GWRS). A multistage sampling technique was adopted in the study with two divisions, Njoro and Gilgil purposely selected. Each of the divisions had 89 maize growing households randomly selected. The sample size thus became 178 households. Data on the socio-economic characteristics of respondents, post harvest costs and maize price movements were collected. Marginal rate of return (MRR) was used to analyze economic benefits of the system and double hurdle model was used to analyze factors that determine farmers' participation in the system and the extent of participation. The organizations that offered warehousing services were National cereals and produce board (NCPB) and Lesiolo grain handlers. On level of awareness of GWRS, 38.76% of the household heads were not aware of the existence of GWRS, 34.27% were aware but were not participating in Grain Warehouse Receipt System (GWRS) while 26.97% were aware and were participating in GWRS. Of the household heads that were aware, 4.27% perceived it as less important maize marketing strategy, 36.75% perceived it as important while 58.97% perceived it as very important. Gender and distance to warehouse negatively influenced farmers' participation in the system while land size under maize production, off farm income, group membership positively influenced farmers' participation in GWRS. Gender and distance to warehouse negatively influenced the extent of participation in GWRS while land size under maize production, group membership positively influenced the extent of participation. After carrying partial budget and marginal analysis, marketing maize under GWRS was the most profitable compared to other post harvest trading options. The study recommends promotion of Grain Warehouse Receipt System, strengthening of farmer owned organizations, women empowerment in agricultural activities promotion of off farm income generating activities and grain driers and collection points made available at distance which farmers access them.

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ACRONYMS AND ABBREVIATIONS

CMA	Collateral management agreements
EAGC	Eastern Africa Grain Council
FAO	Food and Agriculture Organization
FI	Financial institutions
GM	Gross margin
GRN	Goods received note
GWRS	Grain warehouse receipt system
KMDP	Kenya Maize Development Programme
MOA	Ministry of Agriculture
MRR	Marginal rate of return
TAC	Total additional cost
TAI	Total additional income
TRC	Total reduced cost
TRI	Total reduced income
TVC	Total variable cost
WR	Warehouse receipt

CHAPTER ONE

INTRODUCTION

1.1 Background information

Maize is the main staple food in Kenya, accounting for 65% of total staple food caloric intake and 36% of total food caloric intake .The average person consumes 88 kilogrammes of maize products per year (FAO Stat, 2009). The lowest quartile of Kenyan population spends 28% of its income on maize (Kenya Maize Handbook, 2009). Increased productivity, more efficient markets and rational government policies could improve economic contribution of maize sub-sector to become a key element in accelerated growth and poverty reduction (Kalunda *et al.*, 2003). Post harvest losses in Sub-Saharan Africa (excluding South Africa) are generally high, arising from handling, transportation, storage, processing and packaging and marketing. Poor post harvest handling and storage of the harvested maize often results in reduced value of stored grain. In Kenya, it is estimated that 21.1% of total annual maize production is lost through poor post harvest handling techniques (Rembold *et al.*, 2011).The principle contributing factors to the loss are pilferage, damage and consumption by storage pests (insects, rodents and bird), spillage, contamination and spoilage by international standards (Guantai *et al.*, 2007).

As an effort to mitigate post-harvest losses, the government together with development partners introduced the Grain Warehousing Receipt System (GWRS). Under this system, depositors store their grains in parastatal stores or private grain handling service providers. The depositor may be a producer, farmer group, trader, exporter, processor or indeed any individual or body corporate. The warehouse operator holds the stored commodity by way of safe custody; implying he is legally liable to make good any value lost through theft or damage by fire and other catastrophes but has no legal or beneficial interest in it. As certification of their deposition, depositors are issued with receipts from the warehouses. The receipts can be used to access credit facilities from cooperating financial institutions up to 80% of the prevailing maize market prices. After waiting for prices to rise over the storage season, the depositors market the produce and payment made through respective financial institutions. Grain warehousing offers growers options to capitalize on post-harvest price increases. For government and other development organizations,

warehousing is the preferred option as there is no capital cost or need for ongoing management and maintenance of the warehouses by farmers. However, its respective pros and cons do require some long-term decisions to be made.

Collateralized financing is quite new in Africa, and the most common model has been developed around local subsidiaries of international inspection companies. The inspection companies set up tripartite collateral management agreements (CMAs) involving a bank, the borrower and the collateral manager (i.e. the inspection company acting as warehouse operator), which allow depositors to secure bank credit. Depositor takes maize produce to registered warehouses (illustrated in Figure 1) where the warehouse operator assesses the maize delivered and verifies grade. The depositor pays storage and handling costs. The warehouse receipts are issued directly to the financing bank and not to the depositor, and they are non-negotiable and non-transferable. Depositors who do not borrow against the stocks will be entitled to the full proceeds from the sale. However, all depositors have to pay storage costs and collateral management fees. Depositors are also responsible for the cost of transporting the crop to the designated storage site.

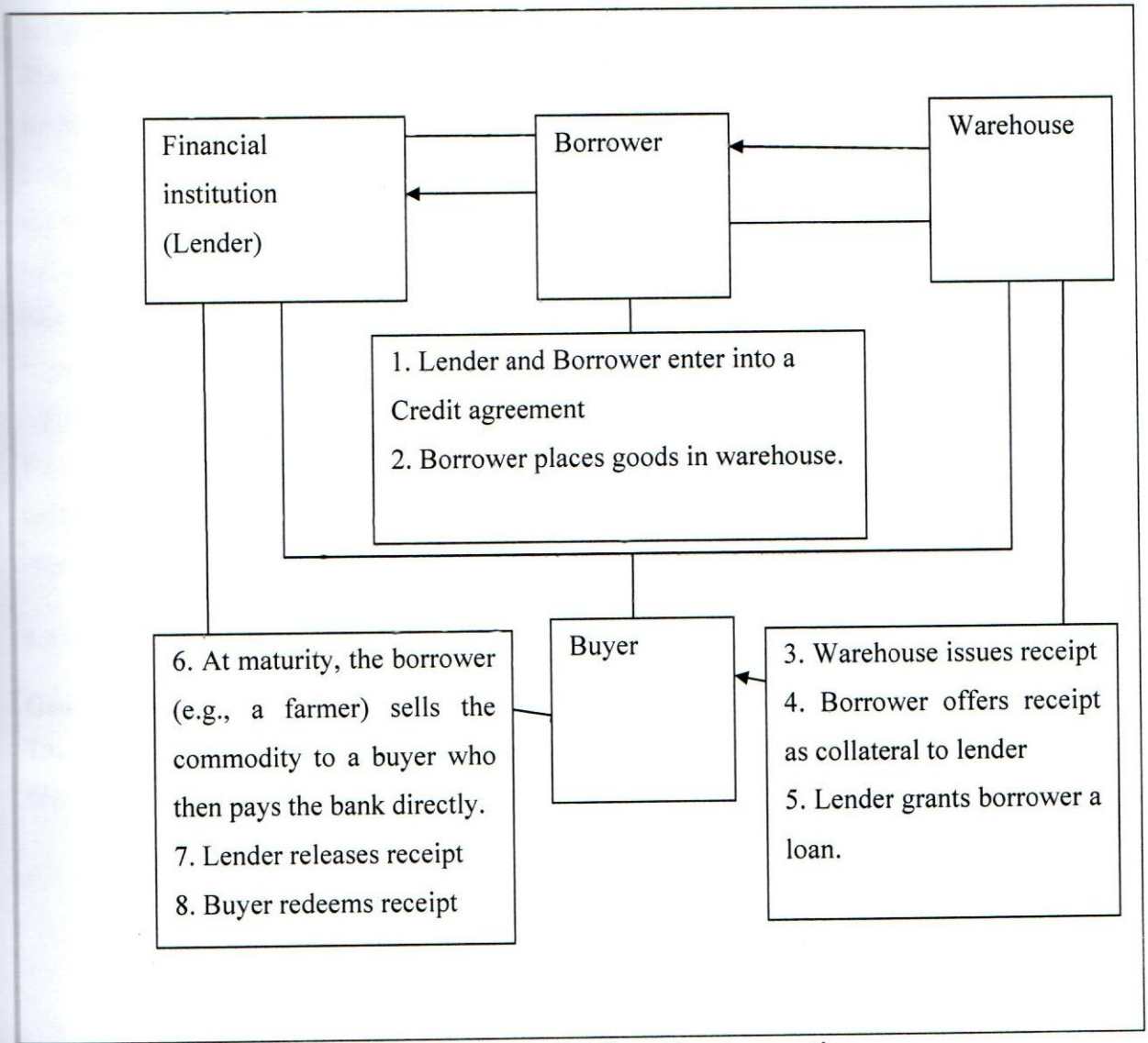

Figure 1: Basic features of a warehouse receipt financing transaction

Source: Kuserwa, (2009)

1.2 Statement of the problem

The seasonality and increasing cost of production has led to fluctuation of maize prices and supply, where the lowest prices are experienced during the first two months after harvest. Maize being the major cash crop and source of livelihood in Nakuru District, farmers sell off most of the marketable surplus soon after harvest to settle their financial obligations and thus receiving low returns which negatively influence household welfare. To ensure farmers benefit from the harvested grains, the government in partnership with development partners has introduced and implemented grain warehouse receipt system. The effort has been achieved with partial success where the actual metric tonnes delivered to the warehouses are far below the forecasted. Farmers' level of awareness, perception and socio-economic factors determining farmers' participation in Grain Warehouse Receipt System remain a knowledge gap that needs to be explored.

1.3 Objectives of the Study

General objective

The main objective of the study was to analyze farmers' participation and performance of Grain Warehouse Receipt System in Nakuru District.

1.3.1 Specific objectives

i) To assess the maize farmers' level of awareness and perception of Grain Warehouse Receipt System in Nakuru District.

ii) To determine the socio-economic factors influencing farmers' participation in GWRS and the extent of participation in Nakuru District.

iii) To compare maize marketing costs and returns under GWRS with other post harvest trading options in Nakuru District.

1.4 Research questions

i) What is the level of awareness and perception of grain warehousing receipt system in Nakuru District?

ii) What factors influence farmers' participation in grain warehousing receipt system and extent of participation in Nakuru District?

iii) What is the difference in maize marketing costs and returns under GWRS and other post harvest trading options in Nakuru District?

1.5 Justification of the Study

Storage as one of the marketing function is key to the realization of producer's goal to generate higher income. Grain Warehouse Receipt System is a risk management strategy which can be used by farmers to better manage market risks and offers growers options to capitalize on post-harvest price increases. The marketing option also offers opportunity to depositors with fair average quality standards grains to receive a share of the market value. It also enables them to wait until such time that the market is conducive to sell the grains and to obtain bank finance to meet investment and other consumption needs without having to sell the crop directly after harvest. While the grain is in storage, the depositor retains ownership of the crop until he/she decide to sell. This is the case even if the depositor borrows a loan.

The study evaluated the performance of the system by analyzing level of awareness, perception and socio-economic factors that influence adoption of the system .The findings play crucial role in improving efficiency in performance of the system aimed at promoting efficient, sustainable grain marketing and widely accessible rural finance. Nakuru District was suitable for the study because it is one of the districts where the system has been operational and a key grain producing zone.

1.6 Scope and Limitations of the study

The study focused on operations of GWRS in Nakuru District and grain farmers particularly maize crop. It also focused on three post harvest trading options namely; instant sales, on farm storage and GWRS. Due to diverse constraints coupled with geographical difference the results obtained from the study may not be applicable to other parts of the country. The data used in the study were from year 2003 to 2009.

1.7 Definition of terms

Warehouse receipt (WR): Document issued by warehouse operators as evidence that specified commodities of stated quantity and quality have been deposited at particular locations by named depositors.

Warehouse Receipt System (WRS): Commodities deposited in a designated warehouse enables the access of credit (collateral) to the depositor.

Adoption: Process in which farmers acquire and use new technologies.

Depositor: Producer, farmer group, trader, exporter, processor or indeed any individual or body corporate to whom a Goods Received Note for storage of grain has been issued

Goods received note (GRN): Grain storage receipt giving evidence of the quantity of grain deposited, grade and other information.

Warehouse operator: Any person who operates a grain warehouse

Marginal analysis : A procedure for calculating marginal rates of return between technologies, proceeding in a stepwise manner from a lower-cost technology to the next higher-cost technology, and comparing marginal rates of return to acceptable minimum rates of return

CHAPTER TWO

LITERATURE REVIEW

2.1 Maize production and post harvest handling in Kenya

Liberalization of agricultural markets by African governments has resulted in partial success. This is evidenced by underdeveloped and inefficient markets, lack of adequate storage, poor transport infrastructure as well as lack of strong supporting institutions and instruments that enable producers to manage marketing and price risks. As such, food distribution margins and seasonal price variability is high and has remained so in many countries after market reforms. There has been decline in spatial marketing margins in a number of African countries from the pre- to post reform period, the most notable being Benin (from 63 to 19%). But spatial margins remain high (21% in Malawi, 23% in Ethiopia and 37% in Ghana). Temporal marketing margins are similarly high, ranging between 32% in Malawi and over 100% in Ghana (Coulter *et al.*, 2002).

In Kenya, improving the competitiveness of maize production is a primary means of resolving the food price dilemma. Lower production costs means greater profitability to producers at lower prices while improving consumers' access to food. It also allows domestic producers to compete effectively with imports from other countries. However raising productivity through reducing production and marketing costs has been one of the biggest challenges in Kenya's maize sub-sector (Nyoro *et al.*, 2004). Good post harvest grain management capacity and practice minimizes magnitude of post harvest losses and creates potential employment and income linkages effects and gains from the activities (Gabriel *et al.*, 2006). Reduction in post harvest losses helps in increasing availability of maize to a greater extent to the population. This can be achieved by assessing the losses in maize at various stages of handling that would help in identifying factors responsible for such losses and develop measures to minimize them. Such measures include proper storage, transportation and timely availability of labour (Basappa *et al.*, 2007). Lai *et al.* (2003) concluded that farmer's risk aversion, storage costs, interest rate and underlying probability distribution of prices determine optimal distribution of sales over the storage period and that risk averse farmers sell a proportion of their maize early to reduce risks.

Coulter (2006) observed that while collective marketing is proving to be successful with staple crops in some cases, it has generally been more difficult than with higher value cash crops. It is probable that the explanation lies in differences in the benefits and costs of cooperation for higher and lower value crops respectively. The act of cooperating with one's neighbors involves considerable 'hidden' costs of a kind that are not usually reflected in group profit and loss accounts, including: Costs that individuals incur from loss of autonomy within the group – to buy and sell produce of any quality, to whom they want and when they want, the opportunity cost of time spent in meetings and communications with other group members, costs of enforcing agreed behavior on officers, staff and other group members. He commented that on-farm stores offers alternative for grain storage though they are mainly used for temporary storage because they have few and outdated facilities. This makes farmers sell their produce soon after harvest with lower cost resulting in low profitability.

2.2 Role of Grain Warehouse Receipt System

Onumah (2003) observed that policy environment, particularly ad hoc interventions occasioned by short-term reactions to symptoms of market inefficiency are the main challenge in establishing warehouse receipt system in Africa. He also commented that there is need to involve small holders' direct participation for the process to be sustainable. He concluded that warehouse receipt system contributes towards increased rural farm income by improving agricultural trade through access to sustainable rural finance. In dealing with risks associated with movable collateral, Bessis (1998) commented that lenders can mitigate credit risk by using the stored commodity as collateral which are readily available to rural producers and may be less difficult to liquidate than most assets traditionally accepted by financial institutions (FI) as collateral. Coulter *et al.* (2002) observed that credit risks can be reduced by the warehouse operator's guarantee of delivery from a stated location. Moreover, they pointed out that the risk of loss of value of the collateral can be reduced by monitoring movements in its market value as well as by margining and the use of price risk management instruments. Foreclosure can be made simple and at low cost, without any resort to the courts depending on how the financing is structured.

The warehouse receipt system can contribute to improved commodity marketing through: reduced information asymmetry between counter-parties on the quality and quantity of commodities to be traded, and curtailing cheating on weights and quality. The WR system facilitates agricultural trade, provision of information on inventories to be collated and disseminated to major buyers at little or no cost. This system can help smallholders bulk up their crop and sell further down the marketing chain to large traders, processors and to regional markets for a better price. It also provides grain storage in well-run warehouses or silos, thereby reducing post-harvest losses, which are quite substantial in Sub-Saharan Africa and often mean significant loss of income to farm households. Similarly, the system enables producers to defer sale of produce by making use of inventory credit to satisfy immediate consumption needs (Onumah, 2005).

Different maize marketing strategies are available for farmers. They include: harvest and store at cooperative stores and wait for the prices to increase, pre-harvest forward contracts, harvest and store in own silo, harvest and store in silo bags, sell on spot at spot market, use the maize as animal feed. However there should exist understanding on how each of the options works and their respective advantages and disadvantages (Cass, 2009). O'Brien (2002) concluded that grain marketers vary individually in their attitudes toward accepting and managing price risk and attitudes range from those who have a strong preference toward avoiding price risk to those who actually prefer to use risky grain marketing strategies that have the potential for returning higher selling prices. Most grain producers (and people in general) are thought to be risk averse, preferring to avoid risk when given the opportunity.

In their study, Dorward, *et al.* (2005) observed that if on-farm storage facilities are a sunk cost, lower variable cash costs make postharvest on-farm storage strategies more profitable than commercial storage. Therefore, in order to reduce transaction risks and costs, there is need to develop institutional arrangements like farmer and trader associations, commodity exchanges, market information systems, warehouse receipt systems, brokers, contract farming and physical market development. Additionally, there is need to invest in feeder roads to help rural farmers to reduce transport costs. Government investments in specific marketing infrastructure such as village, district and urban markets, go-downs and warehouses may also be needed to promote

marketing strategies, reduce transaction costs and risks. Government price setting and market operations affect wholesale prices and also reduces the standard deviation and coefficient of variation of prices. Imposing maize import tariff raises open market price levels and because 65 percent of the rural small-scale farm families are typically net buyers of maize, policies that raise maize price levels are likely to have highly concentrated benefits and anti-poor distributional effect (Nyoro *et al.*, 2005).

2.3. Level of awareness and perception of Grain Warehouse Receipt System

Negatu, *et al.* (1999) observed that perception is one of factors that influence farmers' decisions to adopt a new agricultural technology. Perception of the relevance of technologies is largely influenced by farmers' level of education as observed by Oladele (2001). He also concluded that, the bigger the farm size the better the perception of the relevance of technologies. Ndaghu (2000) concluded that technology that is perceived to sustain means of livelihood will be adopted by farmers. Smathers (1992) concluded farmer's attitude and perceptions than any other factor are likely to determine adoption of conservation practices. Alonge *et al.* (1995) found that compatibility of sustainable practices with their farming systems, farmer's perceptions is rated as the best predictors of adoption of such practices. They found out that attitude towards adoption of technology and contact with extension agents were the main factors influencing the adoption of no-tillage practice (Sheikh *et al.*, 2003). Hence, there is a need to find out what farmers' perceptions are with regards to participation in GWRS.

2.4 Theoretical framework

Farmer's decision to either participate in GWRS or not is modeled as a binary choice as the dependent variable is dichotomous (participate (1) or not participate (0)). In binary choice model expected net utility derived from participating or not participating in GWRS is given as

$$\left.\begin{aligned} Eu_iP &= f(X_i) + e_i \\ Eu_iN &= f(W_i) + e_i \end{aligned}\right\} \quad \ldots (1)$$

Where, Eu_iP is the expected net utility of household i from participating in GWRS and Eu_iN is the expected net utility of household i from not participating. Participation by a household is

denoted by P while non participation is denoted by N. X_i and W_i are independent variables denoting factors influencing the decision to participate and e_i is an error term. Comparing expected net utility from the two decision such that: $Eu_iP- Eu_iN >0$, or $Eu_iP- Eu_iN <0$. I_i is then used to indicate household i participation in GWRS or not, so that $Y_i=1$ if a household participates and $Y_i=0$ if not.

$$\left.\begin{array}{l} I_i = 1 \; if Eu_iP - Eu_iN > 0 \\ I_i = 0 \; if \; Eu_iP - Eu_iN < 0 \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Equation *(2)* shows that expected utility from participating in GWRS is greater than expected utility of not participating on GWRS. The second stage will involve investigation of the extent of participation in terms of proportion of marketable maize surplus allocated for GWRS.

The ability to store and length of time of storage is determined by the amount of input costs the farmer is willing to pay for any storage technique and the ability to wait till the maize stored command high price as suggested by Pinkey (1993). Storage technique is viable if storage value (revenue) exceeds total expense in the storage process. Partial budgeting as employed by Alimi *et al*. (2006) is a method of organizing data and information about the costs and benefits of various alternative treatments/technologies and comparing them.

Partial budgeting has four parts: additional income, reduced costs, reduced income and additional cost (Roth, 2002). Marginal analysis determines economic effect of changing from one technique to another. A marginal rate of returns between the techniques is calculated. Marginal rate of returns (MRR) is the change in gross income to change in total variable input costs between the techniques (Eskersley, 2004). Marginal rate of returns is compared in order to choose the best marketing option. After determining net benefit for each technology, dominance analysis is performed which is done by sorting the technologies, including the current technology the producer is using, on the basis of costs, listing them from the lowest to the highest, together with their respective net benefit. In moving from the lowest to the highest, any technology that costs more than the previous one but yields less net benefits is said to be dominated and can be excluded from further analysis. The computed marginal rate of return gives an indication of what a producer can expect to receive, on average, by switching technologies.

2.5 Conceptual framework

The process of participation in GWRS theoretically consists of maximizing utility. An individual maize producer faced with the alternative "GWRS verses other post harvest trading options" decides to participate in the former only when the combined effect of certain factors reaches a given value. Beneficiaries (farmers) only participate in technologies that suit their needs and circumstances be they technical, social, economical and agro ecological. These factors play an important role in development of analytical techniques in studying performance of GWRS. Profitability and potential preferential of GWRS are necessary to trigger diffusion of the system. However, for it to be sustained, GWRS must be compatible with farmers' economic resources and supported by institutions responsible for providing technical and financial assistance. Physical and institutional factors mainly distance to market, access to credit and socioeconomic factors like education, age, gender, labor, household size play important role in determination of participation in GWRS.

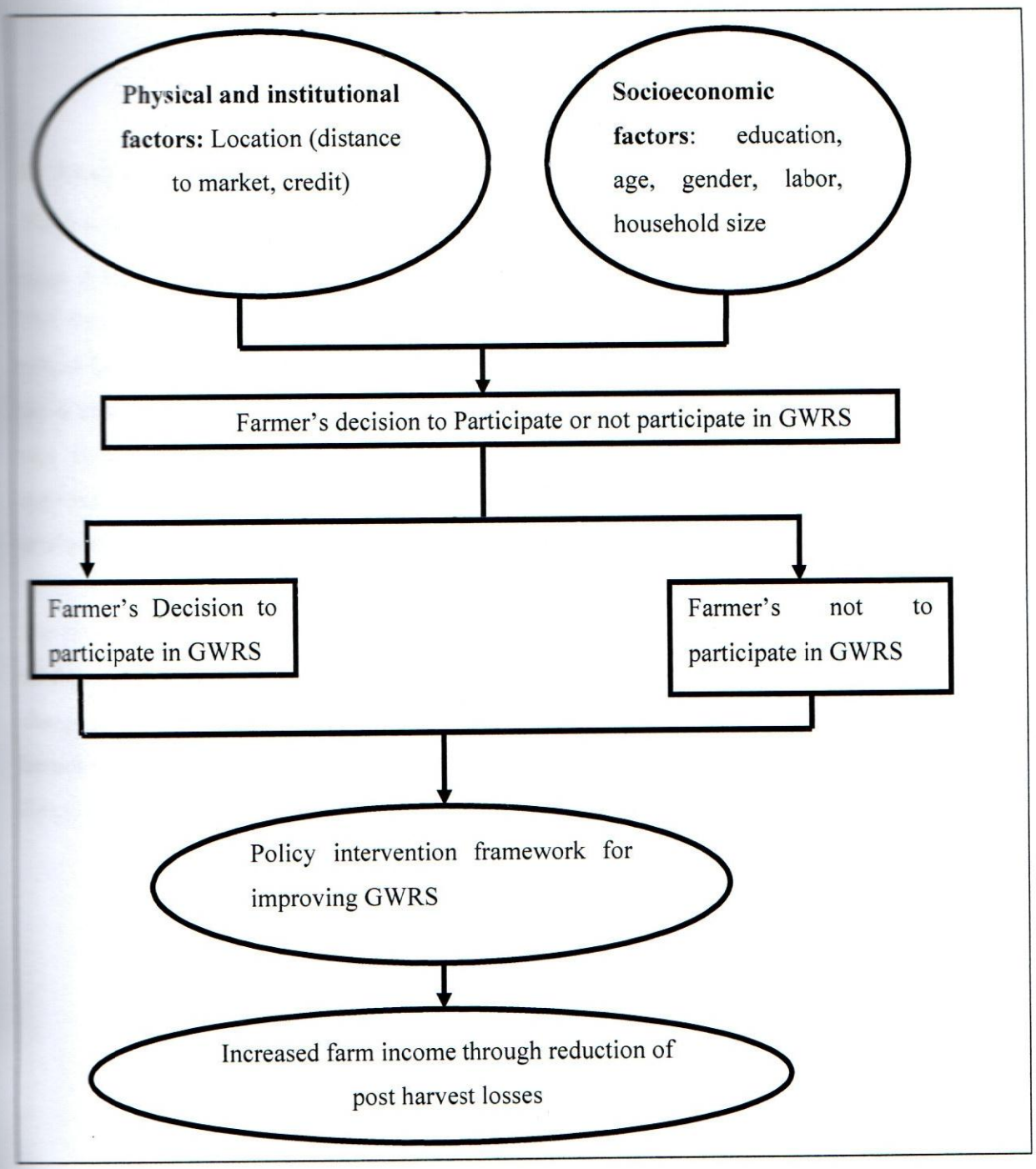

Figure 1: Conceptual Framework of Socio-Economic Factors Influencing Farmers' Participation in Grain Warehouse Receipt System in Nakuru District

Source: Author (2014)

CHAPTER THREE

METHODOLOGY

3.1 Study area

Nakuru district covers an area of 7,242.3 km^2 of which 5,274 km^2 is arable and 283 km^2 is water mass. It is located between longitudes 35^0 28 and 35^0 36' East and latitude 0^0 13 and 1^0 10' South. The four main livelihoods in the district are mixed farming: food crops/livestock, marginal mixed farming, formal employment/business/trade and casual waged labour. Annual rainfall in the district ranges from 719mm to 1282mm in two rainy seasons. The average small scale farm size is 2.5 acres and 1100 acres for large scale farmers while the total population is approximately 1,187,039 million people. The district has 69,881 hectares under maize and produces 1,886,307 bags of maize per production season.

The main crops grown in the district include maize, beans, Irish potatoes, pyrethrum, cut flowers, wheat and fresh fruits and vegetables. Main livestock enterprises include dairy cattle, beef cattle, sheep, goats, poultry, pigs, rabbits, and bee keeping. The district was selected for the study because it is one of the districts that Grain Warehouse Receipt System has been initiated under Kenya maize development programme (KMDP).

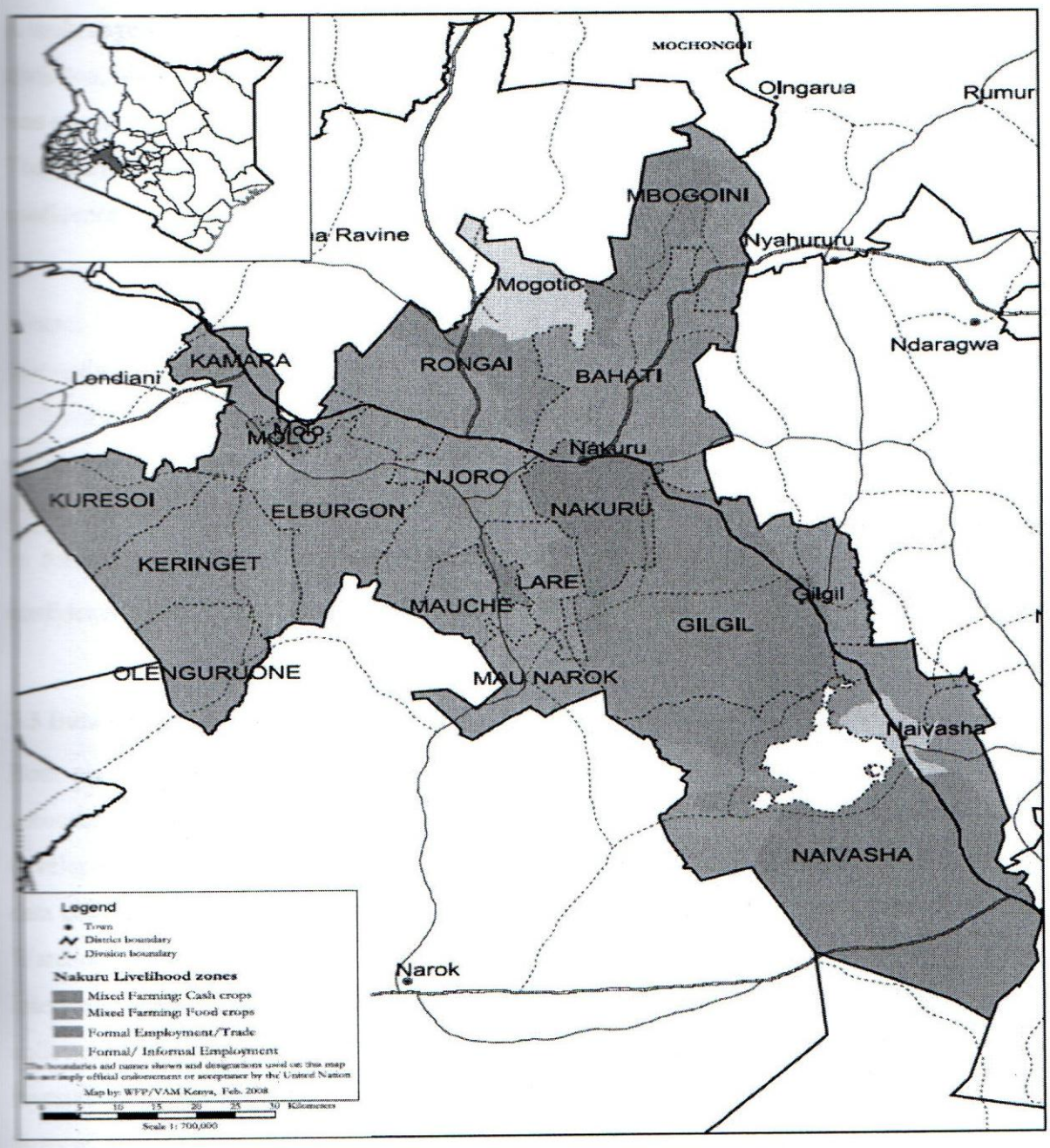

Figure 2: Map of Nakuru District

Source: McLean *et al.* (2008)

3.2 Sampling procedure and sample size

A multistage sampling technique was used to select household that participated in the study. Two divisions, Mauche and Gilgil were purposively selected to represent zones where maize farming was commercialized. Each of the divisions had 89 maize growing households randomly selected. The determination of sample size was through the approach based on the precision rate and confidence level. The following formula was used (Anderson *et al.*, 2007).

$$n = \frac{Z^2pq}{e^2} \qquad (3)$$

Where;

n = optimum sample size,

Z = Normal variant associated with levels of significant.

e = probability of error

p = the estimated proportion maize farmers in the district, and q is 1-p

In the study, p=0.865, Confidence interval is 95% therefore, $z_{\alpha/2}$ =1.96, e = 5 %(at 95% confidence level). The sample size thus became 178 households.

3.3 Data types and collection

Both primary and secondary data were used. Primary data was obtained from farmers and secondary data was obtained from Ministry of Agriculture (MOA), Nakuru district, Kenya maize development programme (KMDP) and Eastern Africa Grain Council (EAGC) offices. Secondary data collected include metric tonnes of maize produce delivered to the warehouses under Grain Warehouse Receipt System and proportion of the households that engaged in maize production. Interview schedules were used in collection of data. Primary data on the following were collected: farmers experience in maize business, number of acres under maize production, capital invested in maize business, transport costs, quantity of maize stored, educational level of the farmers, age of farmers, gender, number of members of the household, purpose of maize production, quantity of maize deposited in GWRS, storage costs, interest charged on loan, maize price movements.

3.4 Data analysis

Descriptive statistics were analyzed for using SPSS software while STATA software was used to analyze factors influencing participation in GWRS and determine the extent of participation.

3.4.1 Descriptive analysis

To analyze the farmers' level of awareness and perception of GWRS, descriptive statistics were used.

3.4.2 Estimation of socio-economic factors influencing farmers' participation in GWRS and extent of participation.

When statistically modeling farmers' participation in GWRS, two important and distinct issues must be addressed: how to model farmers' decision to participate in GWRS and how to model farmers' decision about the proportion of marketable surplus allocated for GWRS, conditional on the participation decision. Therefore double hurdle model is appropriate for the study because it allows for the observable and unobservable factors that affect participation to differ from the factors that affect extent of participation unlike tobit model which forces the participation decision to be identical to the extent decision.

The participation decision is typically addressed by a simple "Yes"/"No" question in the collection of data. If a farmer participates in GWRS (answering "Yes" to the participation question), a second question is asked, eliciting some measure of the respondent's extent of participation, the proportion of marketable surplus allocated for GWRS. Decisions about to participate can be motivated by a latent variable model linking unobserved utility derived from participation. Formally, an individual's decision to participate in GWRS can be represented by an indicator function;

$$I_i^* = \propto Z_i + v_i \quad \ldots \ldots (4)$$

Equation (4) is often referred to as "first hurdle" in the two step process, where I_i^* is an unobservable indicator variable that determines whether or not individual i participated in GWRS (I_i^*=1) or not (I_i^*=0). $\propto$ is a vector of unobserved parameters to be estimated, Z_i is a vector of observed independent covariates that explain individual I's decision to participate in GWRS, and v_i is an unobserved random variable capturing all factors other than Z_i that influence

the decision to participate in GWRS. Formally, Equation (4) implies that individual *i* will participate in GWRS if $\nu_i > -\alpha' Z_i$, and the probability of observing individual *i* participating in GWRS is $P(\nu_i > -\alpha' Z_i).\propto$

An individual's decision about extent of participation can be represented by a function

$$g_i^* = \beta' X_i + \varepsilon_i \quad \ldots\ldots (5)$$

Where:

g^*_i is a latent variable reflecting proportion of marketable surplus allocated for GWRS

β is a vector of unobserved parameters to be estimated,

X_i is a vector of independent covariates that explain individual *I's* decision about extent of participation,

ε_i is an unobserved random variable capturing all factors other than *Xi* that influence the decision about extent of participation.

Equation (5) is often called the "second hurdle" in the two-step process. The double hurdle model simply relaxes the assumption that the participation decision is irrelevant. It includes the possibility that $P(\nu_i > -\alpha' Z_i) <= 1$. If both ε_i and ν_i are normally distributed and independent random variable with zero mean and constant variance, the likelihood function for the double hurdle model is

$$L_{DH} = \Pi_1 P(v_i > -\propto' Z_i) P(\varepsilon_i > -\beta' X_i) f(g_i \mid \varepsilon_i > -\beta' X_i) \cdot \Pi_0 [1 - P(v_i > -\propto' Z_i) P(\varepsilon_i > -\beta' Xi \quad \ldots\ldots (6)$$

The double hurdle model allows for the observable and unobservable factors that affect participation (ν_i, $\alpha' Z_i$) to differ from the factors that affect extend of participation (ε_i, $\beta' X_i$). Since Z_i can contain variables not in X_i, the double hurdle model also allows for some factors to affect only participation in GWRS, and not the extent. The inclusion of $\Pi_1 P(\nu_i > -\alpha' Z_i)$ Π_0 $(1- P(\nu_i > -\alpha' Z_i)$ in the double hurdle model is a probit model for the participation decision. Because the Tobit model is nested in the double hurdle model, the restrictions placed on the double hurdle model can be tested, using a likelihood ratio test. If L_T is the maximum value of the log-likelihood function for the Tobit model and L_{DH} the maximum value of the log-likelihood function for the double hurdle model, then the likelihood ratio $LR = -2 (L_{DH} - L_T)$ is distributed

as a $\chi 2$ random variable with degrees of freedom equal to the number of parameter restrictions that must be placed on the double hurdle model to produce the Tobit model.

3.4.2.1 Empirical model

d_i^* is an unobserved latent variable, while *EDU is* Level of education in years of schooling , *PDN* is Production per acre in 90 kilogram bags, *GNDER is* Whether the decision to either participate in GWRS or not is made by male or female, *LMZ is* Land under maize production in acres a farmer has , *AGE* is The age of the household head in years , *DIS is* Distance to warehouse in kilometers, *OFFCME is* availability of off-farm income , *CRED* is household access to credit , *HHSIZE* is number of family members a household has and *FG is* household head's membership to farmer group. B_0 is a constant, β_i …. B_{10} are corresponding vectors of regression and ε_i is disturbance term.

$$d_i^* = \beta_0 + \beta_1 * (EDU)_i + \beta_2 (PDN)_i + \beta_3 * (GNDER)_i + \beta_4 * (LMZ)_i + \beta_5 * (AGE)_i + \beta_6 * (DIS)_i + \beta_7 * (OFFCME)_i + \beta_8 * (CRED)_i + \beta_9 * (HHSIZE)_i + \beta_{10}^* (FG) + \varepsilon_i \quad \ldots\ldots(7)$$

Table 1: Hypothesized effects of explanatory variables for double hurdle model in determining factors that influence farmers' participation in GWRS and extent of participation.

Variable	Definition	Description of the variables	Expected Sign
EDU	Education	Level of education in years of schooling	+
PDN	Agricultural potential	Production per Hectare in metric tonnes	+
GNDER	Gender	Whether the decision to either participate in GWRS or not is made by male or female	+ or -
LMZ	Land size	Land under maize production in Hectares a farmer has.	+
AGE	Age	The age of the household head in years	-
DIS	Distance	Distance to warehouse in kilometres	_
OFFCME	Off-farm income	Refers to availability of off-farm income(in KES) a household has.	+
CRED	Credit/loan	Dummy (Yes=1 and No=0)	+
HHSIZE	Household size	Number of family members a household has.	-
FG	Farmer group	Member of farmer group. Dummy (Yes=1 and No=0)	+

3.4.3 Marginal analysis and partial budgeting

Partial budgeting was used for estimating costs and benefits between post harvest trading options and thus comparing them. It has four parts: additional income, reduced costs, reduced income and additional cost (Roth 2002).

Positive effects: $TAI+TRC = P_{2j}Q_{2}j+r_{1j}X_{1j}$.....(8)

Negative effects: $TRI+TAC = P_{1j}Q1j+r_{1j}X_{1j}$.....(9)

Difference :$(P_{2j}Q_{2j} + r_{1j}X_{1j}) - (P_{1j}Q_{1j}+r_{2j}X_{2j})$.....(10)

Where:

TAI= Total additional income of new technique

TRC= total reduced cost of the existing technique

TRI = Total reduced income of the existing technique

TAC = total additional cost of the new technology

Marginal analysis determines the economic effect of changing from one post-harvest trading option to marketing maize under GWRS. A marginal rate of return between the options is calculated. Marginal rate of returns (MRR) is the change in gross income to change in total variable input costs between the techniques (Eskersley, 2004). The computed marginal rate of return gives an indication of what a producer can expect to receive, on average, by switching to marketing maize under GWRS.

MRR is obtained as follows;

$$MRR = \frac{GM_2 - GM_1}{TVC_2 - TVC_1} \quad \text{i.e.}$$

$$\frac{[\sum_{i=2}(P_{2j}Q_{2j} - r_{2j}X_{2j})] - [\sum_{i=1}(P_{ij}Q_{1j} - r_{1j}X_{1j})]}{\sum_{i=2} r_{2j}X_{2j} - \sum_{i=1} r_{1j}X_{1j}} \quad \ldots\ldots(11)$$

$$GM = \sum_{ij}^{n}\left(P_{ij}Q_{ij} - r_{ij}X_{ij}\right) \ldots\ldots(12)$$

Where:

P = price of maize produce.

Q = quantity of maize produce

R = price of the variable input

X = quantity of variable input

P_{ij} = price of maize crop in ith post harvest technique for jth respondent

Q_{ij} = Quantity of maize crop in the post harvest technique for jth respondent.

R_{ij} = Price of variable input in ith post harvest technique for jth respondent

Xij = quantity of variable input in ith post harvest technique for jth respondent.

i= 1…………m

J = 1…………n

m = types of post harvest options.

n= total number of respondents

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio economic characteristics of the household heads.

Socio economic characteristics of farmers were described in the study and results presented in Table 2. The overall mean age was 36.65 years and the youngest household age was 20 years and 77 years being the oldest. For the household which did not participate in GWRS, the household heads had a mean of 35.48 years, standard deviation of 11.52, twenty years being the youngest head and 77 years being the oldest household head. For households that participated in GWRS the mean age of household head was 36.13 years, standard deviation of 10.16, twenty years being the youngest household head and 62 years being the oldest household head. This shows that mean age of households heads that participated in GWRS was higher than that of household heads that did not participate in GWRS. This revealed that older household heads were ascribed to more resources than younger ones hence were less susceptible to maize sales soon after harvest.

For households which did not participate, the mean of the household size was found to be 5.18 members with a standard deviation of 2.25 and 2 and 14 members being minimum and maximum respectively compared to mean household size of 4.8 members with standard deviation of 1.75 and 2 and 7 being minimum and maximum respectively for households that were participating. This revealed that household that did not participate in GWRS had higher number of household members than those households that did not participate. This is attributable to the fact that higher household size put pressure on existing resources hence reducing the chance of participation in GWRS. Land size under maize production (in Hectares) for households that did not participate in GWRS was 1.02 Hectares with a standard deviation of 0.92. The minimum and maximum sizes were 0.42 and 7.50 Hectares respectively. For households that participated in GWRS, the mean land size under maize production was 2.70 Hectares with a standard deviation of 1.28. The results revealed that the minimum was 0.42 Hectares while the maximum was 6.25 Hectares. The overall land sizes under maize production had a mean of 1.47 Hectares and standard deviation of 1.27.The minimum was 0.42 Hectare and the maximum was 7.50 Hectares.

Table 2: Socio Economic Characteristics of Household Heads.

Participation in GWRS	Variables	N	Mean	Standard deviation	Minimum	Maximum
NO	Age	130	35.48	11.52	20	77
	Household size	130	5.18	2.25	2	14
	Land under maize production in Hectares	130	1.02	0.92	0.42	7.50
	Metric Tonnes Per Hectare	130	1.60	1.82	0.20	4.32
YES	Age	48	36.13	10.16	20	62
	Household size	48	4.81	1.75	2	10
	Land under maize production in Hectares	48	2.70	1.28	0.42	6.25
	Metric Tonnes Per Hectare	48	3.07	0.10	0.65	4.32
	Distance to warehouse	48	29.10	11.98	4	80
OVERALL	Age	178	35.65	11.14	20	77
	Household size	178	5.08	2.13	2	14
	Land under maize production in Hectares	178	1.47	1.27	0.42	7.50
	Metric Tonnes Per Hectare	178	2.16	0.1	0.20	4.32

4.2 Education level of household heads

Table 3 shows education level of household heads interviewed. Seven percent had no formal education, 49.4 % had primary education, while 41.6%, 0.56% and 1.1% attained secondary, tertiary and university education respectively. Out of the households that did not participate in GWRS, 9.2% did not have any formal education while 56.9%, 32.3%, 0.7% and 0.7% had primary, secondary, tertiary and university education respectively. For household which participated, 2.1% did not have formal education, 29.1 % had primary education, 66.7% had secondary education, and none had tertiary education while 2.08% had university education. This revealed that majority of household heads that participated in GWRS attained secondary education. This is in agreement with the findings of Dimara *et al.* (2003) which established that higher level of education increased the probability of organic cultivation.

Table 3: Education level of household heads

Education level of household heads			Frequency	%
Participation in GWRS		Not gone to school	12	9.23
		Primary	74	56.92
	NO	Secondary	42	32.31
		Tertiary	1	0.77
		University	1	0.77
	Total		**130**	**100**
		Not gone to school	1	2.08
		Primary	14	29.17
	YES	Secondary	32	66.67
		Tertiary	0	1.00
		University	1	2.08
	Total		**48**	**100**
		Not gone to school	13	7.30
		Primary	88	49.44
	OVERALL	Secondary	74	41.57
		Tertiary	1	0.56
		University	2	1.12
	Total		**178**	**100.00**

4.3 Participation in GWRS, gender and group membership.

Table 4 presents results of distribution of household heads by participation in GWRS, gender and group membership. The results indicate that majority of the households that participated in the study were headed by males (69.1%). Household heads that were attached to farmer group organizations were 35.4% while those that were not attached to any farmer owned group were 64.6%. For household that did not participate in GWRS, 71.5% and 28.5% were male and female household heads respectively. Moreover, 80.8% of these household heads were attached to farmer groups while 19.2% were not. Households that participated in GWRS were represented by 62.5% and 37.5% male and female household heads respectively. For these households, 79.2% were attached to farmer owned organizations while 20.8% were not.

Table 4: Distribution of household heads by Participation in GWRS, gender and group membership

Variable		Participants %	Non-participants %	Pooled Data %
Gender	Male	62.5	71.5	69.1
	Female	37.5	28.5	30.9
Group Membership	Yes	79.1	19.2	35.4
	No	20.8	80.8	64.6

4.4 Level of awareness of GWRS

Figure 3 presents level of awareness of GWRS measured on a likert scale as; not aware, aware but did not participate, and aware and participated. The results showed that 38.76% were not aware, 34.27% were aware but did not participate while 26.97% were aware and participated in GWRS

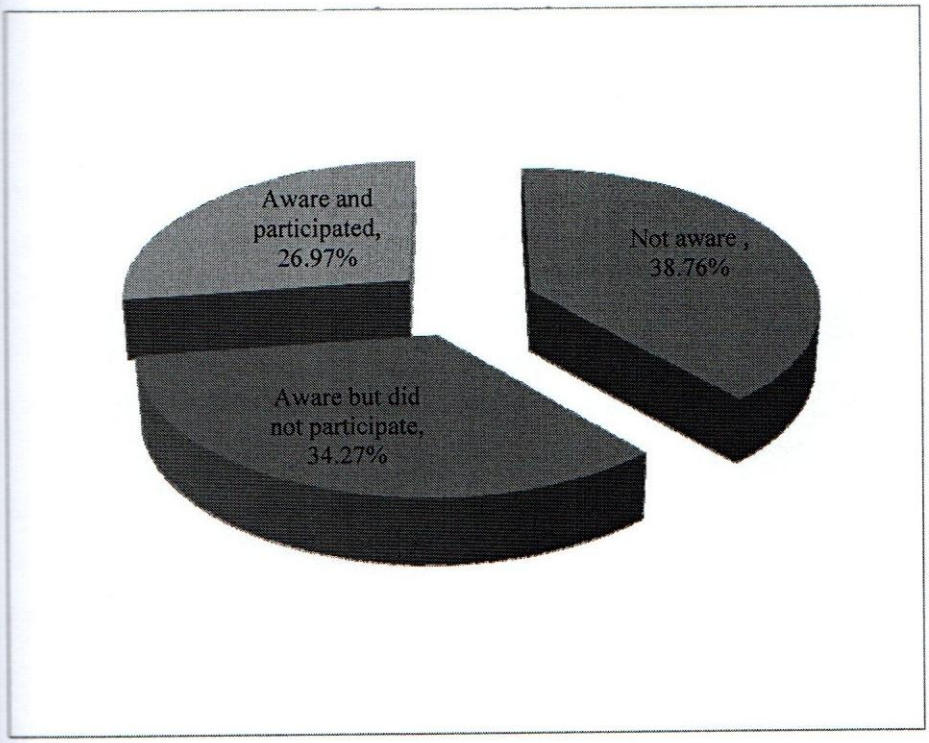

Figure 3: Level of awareness of GWRS

4.5 Perception of GWRS as a marketing strategy

Figure 4 shows how the household heads who were aware of GWRS perceived it as a marketing strategy. The measurement was made on a likert scale as; less important, important and very important. It shows that 58.97% rated it as very important, 36.75% perceived the strategy as important, 4.27 % perceived it as less important. The results imply that more than half of the farmers interviewed perceived Grain Warehouse Receipt System as important in improving marketing of maize produce.

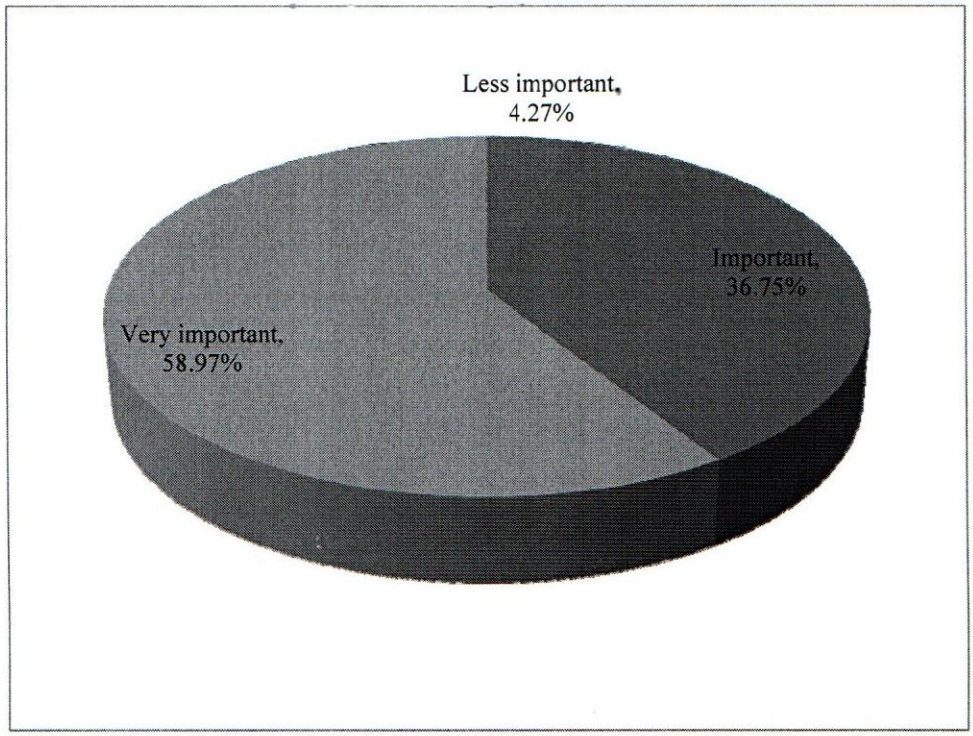

Figure 4: Perception of GWRS as a marketing strategy.

4.6 Factors influencing farmers' participation in Grain Warehouse Receipt System.

Maximum likelihood estimates for probit model was used to estimate factors influencing farmers' participation in GWRS (first hurdle). The results presented in Table 5. To calculate elasticities for the continuous variables of the model, marginal effects of the explanatory variables and their associated standard errors were also evaluated. The dependent variable was farmer's participation (0=does not participate, 1=participates) and explanatory variables were those associated with farmer's socio-economic characteristics. The Log likelihood for the fitted model was -22.7966 and the $\chi 2$ value of 161.93 indicating that all parameters are jointly significant at 5%. Pseudo R^2 of 0.7803 is well above the statistical threshold of 20% indicating that participation in GWRS was attributed to the covariates considered in the model. The results indicate that five variables were statistically significant at 5% level of significance and were according to *apriori* expectations except the gender variable. The probability of female headed household participating in GWRS was 35% higher than male headed households. This differed

with results of Adele *at al.* (2006) which showed that female headed households are more susceptible to instant crop sales than male headed ones. They argued that fewer options are available for female headed households in terms of resorting to other sources of incomes. The most likely explanation for the results obtained is that farming activities are mainly done by women. Moreover, they were more cohesive than their men counterparts as shown that 44% of female headed household interviewed were attached to farmer owned organizations compared to 32% of male headed ones. This enhanced participation in GWRS as women would like to optimize returns as they also benefit from economies of scale that arose from group membership.

Land size under maize production positively influenced participation in GWRS. The combined marginal effect of land size under maize production showed that the probability of a farmer to participate increased by 4% for each hectare that the size is larger than the sample average. This implies that the more the lands size under maize production, the more the total marketable surplus hence enhancing participation in GWRS. Off farm income had a positive and significant effect on participation in GWRS. This showed that as household off farm income increased, the pressure to sell maize soon after harvest to meet family obligations decreased. Sarker *et al.* (2010) experienced similar findings. Membership to farmer owned organizations increased the probability of participation in GWRS by 32%. This is because farmer groups are channels of agricultural information through interaction and interconnectedness in a society, act as collaterals in accessing credit and members benefit from economies of scale. These results are in line with Masuki *et al.* (2006) and Pierre *et al.* (2010).

Distance away from warehouse reduced the likelihood of a household's participation in GWRS. As the distance to warehouse increased, farmers were less likely to participate, all other factors constant. The combined marginal effect showed that the probability that a household participated in GWRS decreased by 0.6% for each kilometre that the sample's average farm was located away from the warehouse. Although age and level of education of household head, access to credit and household size were not significant determinant in household decision on whether to participate in GWRS or not, they exhibited expected signs.

Table 5: Factors influencing farmers' participation in Grain Warehouse Receipt System

Variable	Co-efficient estimates	Standard error	P>|z|	Marginal effects
Gender	-1.7538	0.6215	0.005*	-0.3479
Age	0.0158	0.0263	0.549	0.0019
Education level	0.5604	0.3350	0.094	0.0668
Household size	-0.1248	0.1376	0.364	-0.0149
Land size under maize Production	0.3377	0.0936	0.000*	0.0402
Total marketable surplus	0.0009	0.0010	0.334	0.0001
Off farm income	0.0000	0.0000	0.000*	4.98e-06
Access to credit	0.0789	0.4784	0.869	0.0097
Group membership	1.7266	0.5899	0.003*	0.3151
Distance to warehouse	-0.0496	0.0217	0.022*	-0.0059
Constant	**-2.7285**	**1.3730**	**0.047**	

Log likelihood = -22.7966; χ^2 = 161.93; Pseudo R^2=0.7803; * significant at 5% significant level.

4.7 Factors influencing extent of participation in Grain Warehouse Receipt System.

Table 6 shows the results of maximum likelihood estimations of extent of participation in GWRS, with the proportion of maize marketable surplus allocated for GWRS being the dependent variable. Results of the Tobit model show that five out of ten estimated coefficients of explanatory variables exhibited positive sign and were significant at 5% or better. The coefficients of land size under maize production, gender, household size, and distance to warehouse and membership to farmer group were found to be significant determinants of extent of participation. This confirmed that marketable surplus increased as farm size under maize production increased hence proportion to be marketed under GWRS increased. This is in line with the findings of Damianos *et al.* (2002) which revealed that the larger the farm size, the higher the participation rate in agri-environmental schemes. Female headed households allocated more proportion of marketable surplus to be marketed under GWRS. This could be due to the fact that women were more attached to farmer groups than their male counterparts. Adesina *et al.* (2000) found out that women formed big portion of the population undertaking farming

activities, though they faced inequities in the access, use and the control of household resources. Increase in household size decreased proportion of maize surplus marketed under GWRS. This established that as household members increased, they increased proportion of maize consumption hence reducing marketable surplus. This is in line with findings of Amao *et al.* (2008) which revealed that household size negatively influenced adoption level of improved cassava varieties. The results also revealed that proportion of marketed maize under GWRS decreased as the distance to warehouse increased. This could be attributed to increase in transportation cost of maize to the warehouses. Findings of Bulale (2000) and Yenealem (2006) showed that market distance negatively and significantly influenced adoption decision. Off farm income did not significantly influence the extent of participation in GWRS though it exhibited a positive sign.

Table 6: Factors influencing extent of participation in Grain Warehouse Receipt System.

Variable	Co-efficient estimates	Standar d error	P>|t|	Marginal effects
Gender	-0.3435	0.1558	0.029*	-0.3435
Age	0.0023	0.0078	0.765	0.0023
Education level	0.0503	0.1143	0.661	0.0503
Household size	-0.0934	0.0455	0.042*	-0.0934
Land size under maize Production	0.1045	0.0276	0.000*	0.1045
Total marketable surplus	0.0001	0.0010	0.919	0.0001
Off farm income	0.0000	0.0000	0.106	0.0000
Access to credit	0.1319	0.1602	0.412	0.1319
Group membership	0.5518	0.1678	0.001*	0.5518
Distance to warehouse	-0.0270	0.0079	0.001*	-0.0270
Constant	**0.3686**	**0.4437**	**0.407**	

Log likelihood = -81.908074; $\chi 2 = 110.54$; Pseudo R^2=0.4029; * significant 5% level of significance.

4.8 Constraints to participating in GWRS

Constraints that households faced in participating in GWRS are shown in Table 7. The results revealed that transport challenges was the most constraining factor as identified by 69.90% of

household heads who were aware of the existence of GWRS. Low farm productivity was identified by 52.50% of the household heads, while attaining fair average quality acceptable by warehouse operators as identified by 50.80% of the household heads. Identified by 21.30% of the households, was constraint that arose from farmer group challenges and financial obligations identified by 27.90 % of the household heads.

Table 7: Constraints to participating in GWRS

Constraint		Percent
Low farm productivity	No	47.50
	Yes	52.50
Attaining maize quality	No	49.20
	Yes	50.80
Transport	No	31.10
	Yes	68.90
Farmer group challenges	No	78.70
	Yes	21.30
Financial challenges	No	72.10
	Yes	27.90

4.9 Partial budgeting and marginal rate of returns

4.9.1 Partial budgeting.

Partial budget analysis was used to determine net benefits of switching to marketing maize produce under GWRS and results presented in Table 8.There were no total reduced cost and total reduced income on switching from instant sale and on farm storage to marketing under GWRS. The positive effect of switching from on farm storage to maize marketing under GWRS amounted to KES 4,422 per metric tonne (Total additional income of KES 4,422 plus Total reduced cost of KES 0). The negative effect of the change was KES 1,782 per metric tonne (Total reduced income of KES 0 plus Total additional cost of KES 1,782). This resulted in

change in Gross margin (per metric tonne) of KES 2,640. The positive effect of switching from instant sales to marketing the produce under GWRS was KES 12,705 per metric tonne (Total additional income of KES 12,705 plus Total reduced cost of KES 0). The negative effect of the change was KES 4,345 (Total reduced income of KES 0 plus Total additional cost of KES 4,345). This resulted in change in Gross margin (per metric tonne) of KES 8,360. The results revealed that marketing maize produce under GWRS was profitable because it had the highest difference in gross margin per 90 metric tonne compared with instant maize sale and on farm storage.

Table 8: Partial budget

Switching from On farm storage to GWRS				**Switching from Instant sale to GWRS**			
Positive effects	**Value (KES)**	**Negative effects**	**Value (KES)**	**Positive effects**	**Value (KES)**	**Negative effects**	**Value (KES)**
TAI(per metric tonne)	4,422	TRI(per metric tonne)	0	TAI(per metric tonne)	12,705	TRI(per metric tonne)	0
TRC(per metric tonne)	0	TAC(per metric tonne)	1,782	TRC(per metric tonne)	0	TAC(per metric tonne)	4,345
Total A	**4,422**	**Total B**	**1,782**		**12,705**		**4,345**
Change in Gross margin per metric tonne (Total A minus Total B)			**2,640**				**8,360**

4.9.2 Marginal rate of returns

Marginal rate of returns was used to determine which of the trading options was economically superior. The net benefit between two consecutive options was calculated and results presented in Table 9. Beginning with the lowest-cost option (instant sale) and the next ascending option (on

farm storage) then marketing under GWRS, the marginal rate of return was computed by expressing the difference between the net benefit of the pair as a percentage of the difference of the total cost. The computed marginal rate of return gives an indication of what a farmer can expected to receive, on average, by switching options. The results revealed that marketing maize under GWRS was the best because it had highest rate of return (7.75) compared to on farm storage (5.66).This shows that 7.75 marginal rate of return is realized in switching from instant maize sale to marketing the produce under GWRS. It implies that for each Kenya shilling invested in marketing maize under GWRS, a farmer expected to recover the one shilling invested plus an additional return of KES 7.75.

Table 9: Marginal rate of returns

Variable	Instant sales	On farm storage	GWRS
selling price (KES per metric tonne)	12,727	21,010	25,432
TVC(KES per metric tonne)	9,724	10,967	11,176
GM(KES per metric tonne)	3,003	10,043	14,256
a) change in GM between two consecutive trading options (KES per metric tonne)	-	7,040	11,253
b) change in TVC between two consecutive trading option (KES per metric tonne)	-	1,243	1,452
MRR(a/b)	-	**5.66**	**7.75**

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The study analyzed the level of awareness and perception of Grain Warehouse Receipt System by farmers in Nakuru district. It also determined factors that influence participation in the system and the extent of participation. It further compared the profitability of marketing maize produce under GWRS with other post harvest trading options. The district is one of the key maize producing regions in Kenya and has established grain warehouses. The study concludes that was still low level of awareness of existence of GWRS in the study area. Although majority of households that were aware of its existence perceived it as important strategy in marketing of maize, they were still constrained by socio economic factors from participating. Transportation challenge was the most constraining factor followed by low farm productivity, attaining fair average quality maize acceptable by warehouse operators, financial obligations and farmer group challenges respectively.

Five explanatory variables were found to significantly influence participation in GWRS. Gender of household head and distance to warehouse negatively influenced participation in GWRS while land size under maize production, off farm income, group membership positively influenced participation in GWRS. On the extent of participation in GWRS, five dependent variables were found to significantly influence participation in GWRS. Gender of household head, household size and distance to warehouse negatively influenced while land size under maize production, group membership positively influenced the extent of participation. After carrying partial budget and marginal analysis, marketing maize under GWRS was the most profitable compared to other post harvest trading options hence the marketing strategy is pivotal in advancing maize marketing.

5.2 Recommendations.

From the study the following recommendations are made;

There is need to promote awareness of Grain Warehouse Receipt System. This can be achieved through organizing agricultural exhibitions and media coverage on the operations of GWRS. Strengthening of farmer owned organizations is highly recommended. This is achievable through capacity building and training on organizational development. Empowering women in agricultural activities is desirable. Off farm income generating activities should be promoted to enhance household income. Grain driers and collection points should be made available at distance which farmers access them with ease to counter quality and transport challenges experienced by farmers.

5.3 Areas of further research

The research focused on analyzing the level of awareness of GWRS, determining factors that influence participation in GWRS and extent of participation and further compared profitability under this strategy with other post harvest trading options. This is all geared towards improving household income through maize production hence poverty reduction. Therefore the study proposes the following areas for further research: To comparatively analyze maize marketing through various stakeholders under grain banking, under GWRS and green maize marketing. This will determine the most profitable stage of maize marketing and to comparatively analyze marketing of various cereal crops under warehouse receipt system to determine the most profitable cereal crop marketed under the system.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

This study is conducted to assess farmers' participation and performance of Grain Warehouse Receipt System (GWRS) .Information provided play an important role in formulating policies and programmes that will improve performance of GWRS. All information will be treated as confidential. Your cooperation is highly appreciated.

Date of interview _____

Questionnaire number_____

Name of enumerator _____

Farmers' name_____

District_____

Division_____

Location_____

Village_____

1.0 Farmers' background information

1.1Gender/sex: ☐ Male ☐ Female (*Tick where appropriate*)

1.2 Age (in years) _____

1.3 Relation to head (*Tick where appropriate*)

i) Head ☐

ii) Wife ☐

iii) Sibling ☐

iv) Other (specify)_____

1.4 Education level (*Tick where appropriate*)

i) None ☐

ii) Primary school ☐

iii) Secondary school ☐

iv) Tertiary ☐ Specify_____

v) Others (*specify*)_____

1.5 Household size _____

1.6 How many acres do a) you have? _____

b) You have under maize production? _____

1.7 How many years have you been in maize farming? _____

1.8 How many bags (90kg) a) you get per acre? _____

b) You sell? _____

1.9 What is the sale price per bag (KES)? a) Soon after harvesting? _____

b) After storage in warehouse? _____

2.0 Physical and economic factors

2.1 How much is household off-farm income per year (KES)? _____

	Source	Income(KES)
1.		
2.		
3.		
4.		
TOTAL		

2.2 Land tenure: ☐ Individual Leasehold ☐ Communal (*tick*)

Specify other _____

2.3) Do you access credit to purchase farm inputs? (*Tick*)

Yes ☐ No ☐

2.4) Are you a member of any farmer owned organization? _____

2.5) if yes, how many farmer owned organizations are you a member? _____

3.0 Sources of information

3.1) where do you receive information

a) Radio ☐

b) Television ☐

c) Group members ☐

d) Field days and exhibitions ☐

e) Newspapers ☐

f) Internet ☐

g) Others (*specify*) _____

4.0 Maize crop production cost per acre

INPUT	DESCRIPTION	RATE	QUANTITY	TOTAL
Seed				
Chemicals				
Fertilizer	DAP			
	CAN			
Ploughing				
Harrowing				
Casual labour				
Permanent labour				
	Planting			
	Weeding			
	Top-dressing			
	Harvesting			
	Storage			
Gunny bags				
Phone and post				
Administration				
TOTAL EXPENSES				

5.0 Information on GWRS

5.1) Do you participate of GWRS (Tick) YES ☐ NO ☐

5.2) level of awareness of GWRS (tick where appropriate)

1= Not aware at all ☐

2=Aware but does not participate ☐

3=Aware and participating ☐

5.3). If you are aware of GWRS, how do you perceive it?

1= Low importance ☐

2 = Important ☐

3 = High importance ☐

4.3) List constraints that you encounter in participating in GWRS

Constraints ranks		**Perceived possible solution**	
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	

Constraints ranks		Perceived possible solution	
7		7	
8		8	
9		9	

Constraints codes:

A=low farm productivity

B=lack of information

C= attaining maize quality standards required

D=transportation challenges

E=farmers group challenges

F=complexity in accessing credit

G=financial obligations

H=high storage costs charged by warehouse

6.0 Post harvest details

6.1). How do you plan for your maize produce surplus soon after harvest?

Trading option	Number of bags(90kg)
Sale	
On farm storage	
Warehouse storage	
Total marketable maize produce	

6.2) Name of the nearest grain handler _____

6.3) Distance to the nearest market (km) _____

6.4) Distance to the nearest grain warehouse (km) _____

6.5) Total transport cost to the market (KES) _____

7.0 Post harvest costs

7.1) Indicate the post harvest costs on the maize produce per 90kg bag

Activity	**cost per 90kg bag**		
	Post harvest trading options		
	Sell after harvest	**On farm storage**	**Warehouse storage**
Shelling			
Drying			
Chemical costs			
Fumigation cost			
Renting of store			
Transportation cost			
Storage loss cost			
Material costs			
Interest cost on loan			
Loan arrangement fees			
Handling cost			
Storage cost			

Activity	cost per 90kg bag		
	Post harvest trading options		
	Sell after harvest	On farm storage	Warehouse storage
Unofficial costs			
Total cost			

8.0 Maize price movement

Month	Price per 90 kg bag(KES)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	